METROCABLES IN MEDELLÍN, COLOMBIA

An innovative, inclusive and green transit system.

Spatial inequality is closely linked to wider social inequality and lack of mobility or access to transport can turn spatial marginalization into deeper social exclusion. This case study shows how accessible, affordable urban transport schemes run on clean energy can generate multiple co-benefits, simultaneously reducing poverty, social exclusion and carbon emissions. It also highlights the important role of local municipalities in driving, planning and financing equitable and sustainable city-wide transport systems. In the short term, public transport is vulnerable to health pandemics such as COVID-19 but in the medium and longer term can play a vital role in building a fair, inclusive and green recovery.

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EXECUTIVE SUMMARY

The aerial Medellín Metrocable system is an innovative public sector project that connects informal low-income neighbourhoods in steep and inaccessible areas, known as '*comunas*', to the rest of the city. The communities are mostly informal, low-income, settlements that have been built up on the steep hillsides of Medellín. The terrain made travel to the city time-consuming and challenging for residents and meant that the *comunas* were relatively isolated from the rest of the city, along with its services and employment opportunities. Moreover, in the latter part of the 20th century these areas had become afflicted by poverty, violence and the drug trade. The reduction in violence in the early 2000s helped to open the door to a programme of urban improvements.

The aerial cable car lines are a low-cost, inclusive, innovative and green transport scheme that have helped increase mobility for people in the *comunas* through easier and shorter journeys to the city centre and employment zones in the south of the city. This in turn has contributed to income growth, reduced stigmatization of the *comunas* and reduced congestion. As the scheme, was powered by hydroelectricity it also simultaneously reduced carbon emissions.

The Metrocable was accompanied by other initiatives that aimed to develop *Comunas* 1, 2, 7, 8 and 13. Other improvements have included new schools, public libraries, public spaces, football pitches and environmental improvements. The Integrated Urban Projects (*PUI* in the Spanish acronym) had a comprehensive strategy of urban upgrading that was focused around the transportation project.[1]

A *comuna* in Medellín, Photo by Bryony Wallace.

KEY INSIGHTS

Although Medellín is still one of Latin America's most unequal cities, this case study shows how accessible, affordable urban transport schemes run on clean energy can simultaneously help reduce poverty, social exclusion and carbon emissions. It highlights the important role of local municipalities in driving, planning and financing equitable and sustainable city-wide transport system.

Design features that contributed to the scheme's overall positive impact at scale include:

- The recognition that spatial inequality is an important form of poverty which accessible and affordable transport schemes can help reduce.
- The use of green electricity to power the scheme, in this case provided by existing hydroelectric power stations, which simultaneously reduced carbon emissions.
- The important role of the local public municipality in funding, coordinating and planning the scheme.
- The importance of community engagement, following lessons from the failure to do so initially.
- The scheme was relatively low-cost and financially self-sustaining.
- Relatively little land needed to be purchased – mostly for the stations – as the Metrocable lines operate above existing buildings. This reduced the negative impact of displacing people and allowed the Metrocable to be integrated into existing communities.
- The project required a high level of institutional capacity and planning ability but once established the technology requires relatively little maintenance.
- The implementation of a complementary public projects to improve urban areas, reduce poverty and car use.

Comuna 13, Medellín. © Bryony Wallace

WHAT HAS CHANGED?

THE CHALLENGE

Political violence in rural areas of Colombia drove many people to the cities in the 1950s and 1960s. The result was the development of informal settlements on the hillsides surrounding Medellín. By the end of the 1990s, these *comunas* were the most densely populated areas of the city, with over 400 dwellings per hectare.[2] During the same period, Medellín became a focus of the global drug trade; this brought more violence and, by the 1990s, it was the most violent city in the world. This peaked in 1992, with 381 murders per 100,000 people.[3] The worst violence was centred on the *comunas*, and their inaccessible geography meant that law enforcement agencies rarely ventured into the areas plagued by conflict.

Poverty and violence in these areas were compounded by the sudden liberalization of the national economy, which forced a restructuring of the traditional manufacturing economy in Medellín. This pushed poverty rates and unemployment to exceedingly high levels and exacerbated inequality. Consequently, people in the *comunas* were isolated from the city and from employment opportunities. Housing in the *comunas* was largely informal and road infrastructure was poor. There were taxi and bus services, but trips to the city centre were long. This context contributed to a lack of opportunities, high unemployment, low-income levels and violence. The deep inequalities that characterized Medellín were an amalgamation of these factors.[4]

These inequalities led to the stigmatization of communities at the fringes. They were no-go areas for police and the military due to the high levels of violence and the presence of the Revolutionary Armed Forces of Colombia (FARC), the National Liberation Army and the People's Armed Commandos in *Comuna 13*. The little tourism there was in Medellín at the time did not reach these parts of the city. The *comunas* were afflicted by, and associated with, the drug trade, violence and poverty. Thus, spatial inequality led to stigmatization and compounded the issues faced in these communities.[5]

THE METROCABLE LINES

The Metrocable lines were established as an innovative transport solution to link people living in Medellín's *comunas* with the centre of the city, as part of a targeted poverty reduction scheme. They were accompanied by other improvements, including new schools, astro-turf football pitches, business start-up centres, libraries, parks and general improvements to public spaces.[6]

The earliest pioneering Line K was completed in 2004 and connects Comunas 1 and 2 to the city. Line J was completed in 2008 and connects Comunas 7 and 13. The third line, Line L, completed in 2010, was not designed for commuting but connects the city to Parque Arví, a national park. A fourth Metrocable line, Line H, was completed in 2016 and is another commuter route, serving Commune 8.[7] The most recent, Line M, began operating in early 2019. Line P was expected to go into operation before the end of 2019 but, as of January 2020, it had not yet been inaugurated.[8] This case study focuses on the earliest Metrocable lines, Lines K and J (2008) as Line L is not used for commuting and the later commuter lines, Line H and Line M, have been built too recently for their impact to be evaluated.

Three successive mayors of Medellín played a central role in driving the project forward. But the Metrocable project was initially proposed by the publicly owned Metro Company (Empresa de Transporte Masivo del Valle de Aburrá – Metro de Medellín Ltda.) in 1999, based on a Metropolitan Road Plan of 1985 which highlighted the need to link low-income and inaccessible areas to the rest of the city.[9]

Table 1: Metrocable lines, basic information

Line	**K Line**	**J Line**	**L Line**
Launch date	August 2004	March 2008	February 2010
Construction time	14 months	15 months	10 months
Length	2,072m	2,782m	4,469m
Commercial speed	5 m/s	5 m/s	6 m/s
Number of pylons	20	31	25
Number of stations	4 (including Metro station)	4 (including Metro station)	2
Number of cabins (capacity 10)	93	119	27
Distance between cabins	60m	60m	340m
Operational capacity	3,000 passengers per hour	3,000 passengers per hour	1,200 passengers per hour
Estimated total cost	US$24 million (at average 2003 exchange rate)	US$47 million (at average 2007 exchange rate)	US$21 million (at average 2009 exchange rate)
Cost per kilometre	US$11.6 million	US$16.9 million	US$4.7 million
Funding sources	Municipality: 55% Metro: 45%	Municipality: 73% Metro: 27%	Municipality: 38% Metro: 34% Provincial government: 17% Transport Ministry: 9% Other: 2%

POVERTY REDUCTION

Spatial inequality is often closely tied to wider social inequality and lack of mobility or access to transport can turn spatial marginalization into deeper social exclusion. Conversely, greater mobility implies greater employment opportunities and access to services which can help reduce poverty. The main impact of the Metrocable has been increased mobility for people in the *comunas* through easier and shorter journeys to the city centre and employment zones in the south of the city.

Reach

Around 695,000 people live in the neighbourhoods now connected to the city by the Metrocable network. Line K has a catchment area of 23 neighbourhoods with a population of approximately 230,000,[10] and allows the 2.1km journey from the Porce River (Rio Porce) to the top station (400m above the Aburrá valley) to be made in 15 minutes. Before the Metrocable, this journey would have taken over an hour. By 2012, the same line had reached a then near-maximum daily capacity of 30,000 journeys.[11] Line J passes through 37 neighbourhoods with a population of approximately 315,000.[12] This line had fewer than half the number of passengers of Line K by mid-2012, but the number of users has been increasing.[13]

Poverty reduction

The overall impact of the Metrocable system has been positive although there are also some limitations (see below). Its precise impact is difficult to measure and evaluate due to the wider urban improvements occurring during what was a period of mass change in the city. Nevertheless, studies suggest that the Metrocable has contributed to the following improvements in the neighbourhoods around Line K:

- Income growth linked to increased access to jobs and associated increase in home ownership;
- Reduced stigmatization of communities in the *comunas* as they have been visibly reconnected to the city and authorities are able to reach these areas again;
- Positive environmental impacts/reduced carbon emissions.

However, it is difficult to isolate the impacts of the scheme from other factors, including wider government investment in public services.

Increased income

Annual incomes for household heads in *Comunas* 1, 2, 7 and 13, which are linked to Lines J and K, increased between 2004 and 2009, although wages were still comparatively low. Table 1 (taken from a 2013 study by Coupé and Cardona) outlines how wages changed over the period. The minimum wage was not sufficient to sustain a family, but by 2009 annual incomes in *Comunas* 1, 2, 7 and 13 were above the minimum wage, with

the exception of female household heads in Comunas 1 and 2.[14] The study focused on these four *comunas* because they were served by the two commuter Metrocable lines completed during this period.[15]

Table 2: Average monthly income for male and female household heads by commune, 2004–09

	2004 (Legal minimum wage: US$201)					2009 (Legal minimum wage US$279)				
	Comm 1	**Comm 2**	**Comm 13**	**Comm 7**	**Medellín**	**Comm 1**	**Comm 2**	**Comm 13**	**Comm 7**	**Medellín**
Men	141	142	165	200	**248**	303	310	343	360	**493**
Women	108	110	127	154	**191**	266	269	324	357	**455**

Source: F. Coupé and J.G. Cardona. (2013). Impact of the Metrocables on the Local Economy.

Between 2001 and 2009, the number of households living in a debt-free property increased by 12% in *Comuna 2*, by 16.2% in *Comuna 1*, by 32% in *Comuna 13* and by 11.6% in *Comuna 7.*[16] [17]

Reduced stigmatization

The Metrocable has helped to reduce stigmatization of the *comunas* on several levels. First, it symbolizes to people in these communities that the city values them. For a long time, the *comunas* were ignored, but now they are a focus of financial investment and technical innovation for the city.[18] Most residents feel proud of what has happened to their communities and now feel an authentic sense of inclusion with the rest of the city.[19] Second, the transportation system is very visible. No other form of transport has the same aesthetic as cable cars flying high above the city, visibly connecting these communities.[20] Finally, mobility is a two-way street. The communities' greater access to the city has also enabled the city, including tourists and law enforcement agencies, to reach the *comunas*. The routes are safe and have encouraged visitors to come to the *comunas*. This can be seen as part of re-establishing state control in the *comunas* and normalizing a state presence. Overall, the Metrocable system represents, in different ways, a sense of being seen by the city.[21]

Reduced carbon emissions

In addition to tackling the problems caused by limited mobility, the Metrocable system has had a positive environmental impact. Medellín's cable cars are run on predominantly hydroelectric resources and, as a result, the system generates virtually no emissions.[22] This has been aided by *PUI* policies that aimed to promote the use of the Metrocable over private transport.[23] These policies discouraged private transport by limiting car parks and direct vehicle access to buildings within 20 metres of the Metrocable.[24]

Urbanization can lead to congestion and pollution and consequently can contribute to climate change. Growing concerns about over-dependence on fossil fuels and increases in CO_2 emissions have seen a push for transport solutions that reduce congestion and environmental impacts. While the Metrocable project was initially focused on improving mobility

and reducing poverty, during the planning stages the Metro Company (which led on the scheme) also recognized its potential environmental benefits.

Table 3 demonstrates the projected baseline reductions in emissions from using the cable car system powered by hydroelectricity (defined as that which would have resulted from other modes of transport using petrol or diesel). The projected reduction was 121,029 tonnes of CO_2 emissions between 2010 and 2016[25] although the actual reduction reported in the Clean Development Mechanism was 68,993 tonnes. In 2018 that Lines L, K, J and H reduced emissions by 35,792t of CO_2 and 1,106t of other air pollutants.[26]

Table 3: Projected emission reductions from six aerial cable-cars in Medellín

Year	2009	2010	2011	2012	2013	2014	2015	2016	Total
Baseline emissions in tCO_{2eq}	-	14,005	24,434	30,103	30,382	31,189	31,458	32,311	193,881
Project emissions in tCO_{2eq}	-	5,135	9,083	11,208	11,450	11,724	11,980	12,274	72,853
Emissions reduction in tCO_{2eq}	-	8,870	15,350	18,895	18,932	19,465	19,478	20,038	121,029

Source: Grutter, J. (2009) Cable Cars Metro Medellín, Colombia: Clean Development Mechanism Project Design Document Form (CDM-SSC-PDD), Version 1.3 Unpublished document

STRUCTURAL CHANGES

By providing affordable transport, the Metrocable network helped reduce spatial marginalization and its consequences and the historic neglect of the *comunas* by both local and national governments. The positive improvements to mobility and transport [27] are difficult to attribute exclusively to the cable car system due to the wider macro-economic policy changes and city-wide efforts to reduce violence. Nevertheless, some changes to the structural causes of inequality were found to result from the Metrocable.

View over Comuna 13, which is now accessible by the cable car. © Helen Wishart

Increased mobility and access to livelihoods

The Metrocable has made transport to the rest of the city accessible, affordable and faster. Bocarejo (2014) found that accessibility to jobs per individual of working age (IWA) doubled for those living around Line K.[28] In 2000 there were 0.33 jobs per IWA in the study's focus group, while in 2005 there were 0.62 jobs per IWA. In comparison, the control group went from 0.23 to 0.38 jobs per IWA over the same period. The higher level of growth in job opportunities indicates that the benefits of the Metrocable were visible within a year of its completion.

Mobility has had a double positive impact. In addition to enabling greater access to job opportunities, it has improved access to the *comunas*. This is in part related to the reduced levels of violence in the *comunas* produced by social improvements, but it is also because the Metrocable has enabled easy travel. This has meant that the police will now enter the *comunas* (in the 1990s they were no-go areas), and tourism is a growing source of income and employment.

Changes to institutional policies and practices

The Metrocable and associated programmes were part of a new 'social urbanism' (a broad term for urban intervention) in Medellín. The municipal administration was striving for social change to mark a new period of the city's history in the new millennium. The city was striving to make a break from a period marked by a lack of social cohesion, violence and economic stagnation.[29] The goal was to build, literally, a

new ‘social contract’ through the provision of public spaces and a more welcoming environment.[30] Working with local communities, the municipal government aimed to repay a historic debt with a new attitude and new policies to help the poorest areas of the city.

LIMITATIONS

There are limitations, however, to the Metrocable scheme. They carried an estimated 10% of daily trips in 2010 although this has expanded subsequently (Brand and Davila, 2011).[31] For example, the capacity of Lines K and J are limited to 3,000 passengers per hour in a single direction which limits further improvements in accessibility. However, the latest Metrocable line, line P, under construction will have a larger capacity of 4,000 passengers per hour.[32] This is partly because it has larger gondolas, which can carry 12 passengers rather than 10. Secondly, accessing the transportation system can involve long walks to reach the terminals and long queues at peak periods; queuing times have reportedly reached up to an hour. Additionally, recent research focusing on school-aged students in *Comuna 13*, which is served by Line J, suggests that the Metrocable has not reached as deep into the commune as anticipated or improved accessibility as predicted.[33]

Thirdly, the economic benefits of using the Metrocable vary depending on the length of the journey and the destination. For example, a single adult ticket covering the Metrocable or Metro and bus makes the Metrocable economically beneficial for long journeys involving a transfer to another form of transport, with a financial saving of approximately 33% compared with two bus journeys. Moreover, between 2000 and 2005 the average price of travel in Medellín increased, but the areas around Line K had the lowest average increase in travel fares across the city.[34] However, a journey that does not involve a transfer, for example on an ordinary bus, may be cheaper and faster once the journey to the cable car terminal and waiting times are accounted for. Finally, Metrocable lines have proved most effective when implemented along with parallel schemes; their impact is limited without accompanying schemes such as low fares and discouraging private vehicles.

In addition to these practical limitations, the positive impacts of the Metrocable have varied across different social groups. Because the transportation system is most beneficial for long journeys, the main group of frequent users consists of workers in the formal sector (i.e. construction or industrial); this socio-economic group is most likely to have work patterns involving long north-to-south journeys because they benefit most from the reduced travel price and time savings. Those who use the Metrocable least are the lowest earners, because of cost, and the highest earners, because they are more likely to own a car or a motorcycle. Other workers are excluded because large loads are forbidden on the Metrocable (but permitted on the bus system).[35] Thus, relatively mid-level earners in the *comunas* are most likely to benefit from the Metrocable system, though households in the *comunas* are among the poorest in the city and many live in poverty. Additionally, some

people were displaced by the land purchases required to build the Metrocable stations, but the number was relatively low in comparison with alternative transportation solutions.

Some groups have had adverse experiences on the Metrocable. Women have expressed concerns about aggressive behaviour experienced when using the system and have reported a culture that makes them feel unable to express their discomfort or respond to the abuse. Men have also mentioned the harassment faced by women. Line J is considered less safe, according to data taken from both the cable car and bus networks, and this supports a general perception that the areas around Line J are more violent.[36] The main concern of the elderly and disabled people is that the transport system in Medellín is not always accessible or it requires additional assistance to access.[37]

More widely social urbanism in Medellín has been criticized for not addressing the deep rooted political and structural causes of previous unrest or challenging the dominance of elites. It is still the most unequal city in Colombia. (Maclean, 2014).[38]

HOW CHANGE HAPPENED

TYPE AND DYNAMICS OF CHANGE

The changes that have come to *Comunas* 1, 2, 7, and 13 were part of a deliberate poverty reduction scheme that aimed to connect these areas to existing public transport networks. The first Metrocable, Line K, was implemented within three years of a promise made by Mayor Luiz Perez. The intentional strategy to repay a 'historical debt' to these forgotten parts of the city involved multiple projects with the Metrocable as the centrepiece. Following the success of the first Metrocable line, introduced in 2004, the second followed quickly and was completed in 2008. Construction took less than two years for both of these lines and so, from the start of planning in 2002, it took just six years for the first two Metrocable lines to be implemented. As already described, improvements were seen rapidly and continued as increasing numbers of people began using the Metrocable.

SCALING PATHWAYS

The initial route to scale was vertical, with the local mayor and municipality using their powers to initiate, fund and implement the cable car lines in the *comunas* of Medellín. Horizontal scaling took place to a small extent within the city as the initial Metrocable was replicated in another area. This replication (Line J) was not as successful as the first line (Line K) as it lacked the extensive complementary urban interventions in *Comunas* 1 and 2. By contrast, *Comunas* 7 and 13 along

Line J did not enjoy the same level of accompanying developments. This has had a real impact, as the Line J catchment area still experiences regular violence between armed gangs, and as a result, residents may risk facing violence when using the system. For example, a survey carried out in 2010 found that the probability of a person choosing to use the Metrocable was significantly higher in the catchment area of Line K (62.9%) compared with Line J (50.6%). However, this may improve with time, as Line K was more established at the time of this survey.

The Metrocable has been admired worldwide and, as a result, there have been several attempts to replicate its success in other cities and countries. Examples of cities that have attempted to scale up the idea pioneered in Medellín include Caracas, Rio de Janeiro, La Paz/El Alto and Bogotá.[39] One example is in Soacha, a suburb of Bogotá that, like Medellín, faced spatial separations from the rest of the city.[40] However, the attempt to implement a cable car system here ran into a number of problems, including unstable land, institutional weakness of the local municipality and a lack of funding and community engagement.[41] Other cities have encountered similar problems, which suggests that the design features of the Medellín Metrocable outlined above are important for success.

CONTEXTUAL DRIVERS

Various interacting historical, structural, economic, political and environmental factors contributed to the cable car project. In the early 2000s Medellín was at long last emerging from a dark period of violence that had plagued the country. Additionally, in October 2002 President Alvaro Uribe launched Operation Orion, removing FARC from the *comunas* and leading to the declaration of a ceasefire.[42] This helped clear the way for the Metrocable and supporting public services. At the same time, there was a new political motivation among some local policy makers to implement a series of changes that would begin to repair the poorest communities in Medellín.[43]

Wider government poverty reduction schemes

Local government was an important driver of the Metrocable scheme. The municipal administration spoke of ‘building better architecture, which the people can be proud of and [which] builds the community’s self-esteem and sense of belonging’ and of ‘leverage projects’ that would ‘lead to a profound social transformation’.[44] This shift was made possible by the end of the conflict, which allowed the city to begin a healing process.

The changes were driven and supported to different degrees by three mayors who supported social transformation and the development of the Metrocable network. Mayor Perez initially faced cynicism from opposition mayoral candidates and the media over his support for the Metrocable project, proposed by the Metro Company in 1999. He also faced more than political opposition: technical challenges threatened to constrain

change, as no insurance company was willing to take on the risk involved in the Metrocable project, and two contractors failed to obtain the necessary insurance. Perez had to create a trust using public money as a guarantee for the insurance policy, and approximately $10m was held until the first Metrocable line was completed. Perez pushed the project forward using his leadership skills and belief in the Metrocable. His successors, mayors Fajardo and Salazar, continued supporting the project as they too believed in the 'urban socialism' project.[45]

Institutional Practices

Medellín's long history of urban planning capability (the Metro system, for example) and wider municipal commitment to the project also played a role. The Metro Company was central in the proposals, design, funding and operation of the Metrocable network and its technical knowledge of affordable technology helped to drive the project forward.

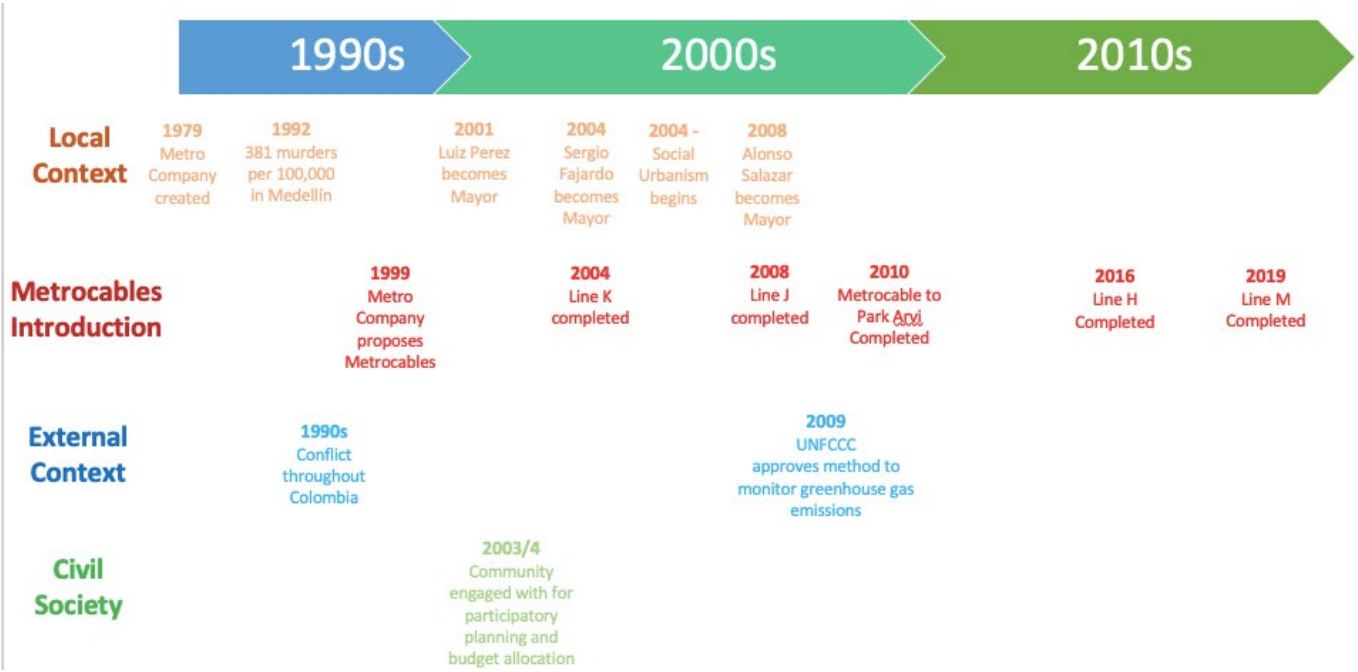
Community engagement

The engagement of municipalities with the community for the implementation of Line K was important to the project's success. Failure to engage with local residents had a negative impact on the second line in Medellín, Line J, and on planning in Soacha and Rio de Janeiro, Brazil. Building relationships was key to establishing trust and to understanding how best to implement the project without disrupting communities. Two noteworthy elements of this engagement were public participation in planning and budgeting.

Colombia's 1991 Constitution included participatory planning to ensure that all developments had a participatory element. Legislation was implemented to ensure that this happened – the programmatic vote (Law 131 in 1994), participation mechanisms (Law 134 of 1994) and the creation of Local Administrative Councils (Law 136 of 1994). The city of Medellín built upon this national framework, and this agenda helped to build trust between the municipality and the *comunas* during the planning process.

Along with participatory planning, the city implemented participatory budgeting, allowing local communities to decide how 5-10% of municipal capital investment was used. This gave citizens input into how demands were prioritized,[46] and was used both during implementation of the Metrocable scheme and in the subsequent urban upgrading projects around Medellín. Although it represented a small portion of the total budget, communities reportedly responded positively, and it has strengthened local development and community organizations. For example, in *Communa 1* the local population have shaped how this budget is used: they have made decisions on a range of issues, from physical developments to providing students with university scholarships.[47]

TIMELINE



Source: Bryony Wallace .

FURTHER DETAILS

THE METRO COMPANY

The Metro Company, owned in equal parts by the Medellín Municipality and the Department of Antioquia, was responsible for the planning and creation of the Metrocable system.

The company was created in 1979 to manage and operate Medellín's mass transportation system. Despite delays to construction of the main Metro system in the 1980s and 1990s, the company's role in the Metrocable project was crucial. While initially it had a strong political element, the company later become more business-oriented in its management; this enabled it to become self-financing and to acquire an AA financial rating.[48] The Metro Company's board of directors is comprised of representative of the local business community and local, provincial and central government officials.

FUNDING

The Metro Company has provided funding for all of the commuter Metrocable lines, and profits from the first two lines helped to enable this. The local government benefits from funding from utility company EPM (*Empresas Públicas de Medellín),* which provides energy for the Metro

and transfers on average 50% of its profits to the city. This makes up 27% of its capital investment and contributes significantly to its capacity to finance the Metrocable network and other urban projects. Between 2004 and 2011, the local government invested $348.2m in the *comunas* and in rural zones.[49] Of this, $225m was invested in public spaces and other public facilities such as libraries; $24m was used to build Line K and $47m to build Line J.[50]

The initial Metrocable line was 55% funded by the city government and 45% by the Metro Company, while subsequent lines were funded to a greater extent by the city; therefore, support from the government is essential.[51] Public funding was feasible due to the relatively cheap nature of the Metrocable's infrastructure:[52] The project required relatively little land to be purchased and the lines were quick to develop.

The initial failure to secure insurance required the local government to hold $10m of public money as a guarantee. This requires capital to manage the risks of construction if insurance companies will not otherwise take the risk.

MONITORING AND TESTING

In order to evaluate impacts on poverty, the mayor's office has coordinated studies relating to the overall transformation of the city and the effects of 'social urbanism' interventions in particular, including the setting up of an exercise to monitor the 'Medellín Model' by the Inter-American Development Bank (IDB).[53] Other regular data collection exercises, covering the whole of the city, include annual quality-of-life surveys, income surveys, real estate surveys and other studies by Medellín's Planning Department. None of these studies focus exclusively on the impact of the Metrocable system;[54] nevertheless, they document various aspects of social transformation in the city and the quality-of-life surveys have been used to give some indication of the impacts that the Metrocable has had. Some academics have carried out independent research which gives further insight into its impacts.[55]

In addition to monitoring the social transformation of Medellín, in which the Metrocable lines have played a part, the Metro Company has made efforts to measure the project's environmental impact. In 2003, during the planning stages, the company formally set out measures to evaluate its environmental contribution by using the Clean Development Mechanism (CDM) framework.[56] It further prepared a Project Design Document (PDD), which was examined by the CDM Executive Board in 2005.[57] This document proposed a methodology to monitor greenhouse gas emissions that result from implementing an aerial cable car system; the methodology was approved by the United Nations Framework Convention on Climate Change (UNFCCC) in 2009.[58]

ANNEX 1: CASE AT A GLANCE

Case study name and implementing organization	**The Metrocable in Medellín, Colombia** **Local municipality**
Geographical location	*Comunas* 1, 2, 7, 8 and 13 in Medellín, Colombia. The Metrocable system connects these neighbourhoods to the rest of the city.
Country indicators	Colombia: Income – Upper, middle-income, with high levels of social poverty Inequality – high levels of inequality with a palma ratio of 3.62 in 2018 (UNU-WIDER, 2019) HDI – high human development, ranked 79th out of 185 countries (HDR, 2019) Gender Gap – low, ranked 22nd out of 153 countries (WEF, 2020) Civic space – 'Repressed' (CIVICUS, 2019) Fragility – 'Elevated warning' (Fund for Peace, 2019) Climate risk index – ranked 44th out of 181 countries for 1999-2018 (Eckstein et al, 2020)
Time period	2004 to the present.
Systemic Challenge	Economic inequality and climate change.
Type(s) of poverty reduction	Reduced spatial isolation Increased social inclusion Increased incomes linked to greater access to employment opportunities and increased tourism Reduced stigmatization. Reduced carbon emissions
Scale of poverty reduction	695,000 people living in the neighbourhoods connected to the city by the Metrocable system which accounted for 10% of daily trips in 2010 and subsequently more. There has been an: Associated increase in average income: average incomes for men and women increased over the period 2004–09 for *Comunas* 1, 2, 7 and 13, which were connected to the cable car network at that time.[59] The average increase was 72%. Associated increase in home ownership between 2001 and 2009: the number of households living in a debt-free property

	increased by 12% in *Comuna 2*, by 16.2% in *Comuna 1,* by 32% in *Comuna 13* and by 11.6% in *Comuna 7.*[60] Reduced carbon emissions: the Metrocable Lines L, K, J and H reduced emissions by 35,792 tonnes of CO2 and 1,106 tonnes of air pollutants in 2018.[61]
Changes to structural causes of poverty	Reduced travel time to city and more affordable public transport. Increased access to employment opportunities and services. More inclusive institutional policies and practices.
Pathways to scale	Scale was initially achieved vertically when successive city mayors used the policy and financial levers at their disposal to establish the cable car scheme. Further horizontal scaling occurred via other cities copying and adapting the scheme to their own contexts.
Limitations	Limited reach in some areas, accessibility varies by social group, some security issue
Types and quality of evidence (strong/medium/weak) for the following:	There is evidence that income and employment opportunities have increased, but the income figures have been question and it is difficult to separate the contribution of the Metrocable from other possible contributory factors. There is stronger evidence about the schemes contribution to some of the outcomes.

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